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ABSTRACT

This report describes various aspects of lesson production and use of the PLATO system at Chanute Air Force Base. The first chapter considers four major factors influencing lesson production: (1) implementation of the "lean approach," (2) the Instructional Systems Development (ISD) role in lesson production, (3) the transfer of programmed instruction techniques to computer based education (CBE), and (4) the general method of lesson production. The second chapter examines the organization's efforts to reduce the time and cost while improving the effectiveness of various management functions by using the PLATO IV CBE system. The last chapter surveys the process of lesson revision and development in order to determine its effects on the lessons and the pedagogical impact of the CBE materials. It discusses the development of eight lessons in specific terms and how these lessons were modified to increase their chances of validation. (Author/DAG)

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Three Aspects of PLATO Use at Chanute AFB:

CBE Production Techniques
Computer-Aided Management
Formative Development of CBE Lessons

MTC Report #11

March 1977

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Introduction

The following chapters describe various aspects of lesson production and use of the PLATO system at Chanute AFB. The first chapter ("Aspects of Lesson Production at Chanute") describes those factors that were most influential in affecting the creative process. The second ("Computer-Aided Management at Chanute") concerns the use of the PLATO system for data management, student testing, and other related CMI aspects. The last chapter ("A Survey of Chanute Lesson Development Techniques") discusses the development of eight lessons in specific terms and how these lessons were modified to increase their chances of validation. It is hoped that taken together these studies will provide some insight into the development and utilization of CBE materials at one military installation.

Chapter 1: Aspects of Lesson Production at Chanute

Abstract

The purpose of this study is to examine the process of lesson production at Chanute AFB during the period of ISD involvement. The report considers four major factors influencing lesson production: implementation of the "lean approach", the ISD role in lesson production, the transfer of programmed instruction techniques to CBE, and the general method of lesson production (group vs. individual). Each factor is discussed in terms of its effect on the quantity and quality of lesson production. This report was submitted to the Chanute PLATO author staff for their comments and suggestions.

Introduction

Background and Objectives

This study is intended to describe some aspects of lesson development at Chanute. It focuses on the process as it unfolded during an important period of the project's existence: June 1974 to June 1975. This was a crucial phase of the project when the Instructional System Development (ISD) group assumed direction of the PLATO effort. A definitive description of the site history is not warranted here. (For further details, consult Himwich, 1977 and Dallman et al., 1977). Only the highlights of the process will be covered in this study. It is hoped that the results of this treatment will be generalizable to other PLATO and/or CBE installations.

Method of Approach

Given the constraints as indicated above, the following factors will be discussed:

1. implementation of the "lean approach" to lesson production;
2. ISD involvement in lesson production;
3. transfer of programmed instruction techniques to CBE;
4. general method of lesson production.

Specific characteristics of individual lessons have already been discussed (Klecka, 1977a, 1977b). In the present study, the factors that were considered to have the most significant effect on lesson production at Chanute were chosen for detailed investigation.

Implementation of the "Lean Approach" to Lesson Production

The lessons written at Chanute were produced according to the basic philosophy of the so-called "lean approach". This consists of incorporating the bare essentials to cover the training objectives without any extra "fat" that might be construed as overteaching the student. The emphasis is on training personnel. Consequently, only enough text is given to describe the subject matter and only a few questions are asked of the student in the course of the lesson.

In Chanute's lessons, the student's progress is measured by a matching test at the end of the lesson: this is known as the Master Validation Exam (MVE) which was used originally for insuring that 90% of the students going through the lesson scored 80% or better on the test. The test and the philosophy of the lean approach make a clear distinction between what a student NEEDS to know and what is NICE to know but is not ESSENTIAL to the performance of the task being taught. The lean approach, when strictly applied, comprises need-to-know material only. (The emphasis is necessary since references to the lean approach are used to justify the specific aspects of individual lessons: see Klecka, 1977a, 1977b.)

The mission of the Air Force technical training is to produce at minimum cost qualified individuals who can effectively perform their duty. Thus, the students are given instruction only for their particular field of specialization. Everything within this training framework relates to that specialized area, at least in theory. There is no interest in giving a broad range of theory and practice in several different areas, as is the case in the private sector, such as a university. This would be

prohibitively expensive and would serve no useful purpose, in the Air Force's view. The airman is prepared to do a specific job, that and no other.

Characteristics

The general characteristics of the lean approach can be distilled as follows:

1. presentation of only material that is essential for performing a specific task;
2. presentation of the minimum amount of such essential material to ensure adequate performance;
3. testing the student on a few important terms/components that are sufficient to indicate familiarity with the subject matter (i.e., the test samples the content area and is not comprehensive);
4. writing the materials originally in an overly lean fashion because overteaching is relatively more difficult to detect than underteaching; later the lessons are "shored up" where necessary to achieve the desired mastery.

The specific characteristics of the lean approach when applied to CBE instruction at Chanute include the preparation of materials with "no frills" (Dallman, 1975, p. 4): that is,

1. little branching except for forced review;
2. multiple choice questions and answers;
3. little feedback for correct or especially for incorrect answers;
4. few elaborate diagrams to accompany and elucidate text;
5. little student control of movement within the lesson;
6. sizeable instructional steps, and
7. perceptible reliance on the techniques of programmed instruction for CBE lesson construction.

These characteristics are significant since CBE lessons are comparatively expensive to produce. Thus, including "frills" was expensive and of doubtful value, in the Air Force's view. Although this philosophy was sometimes distasteful to authors and reviewers, it was defended on the basis of cost-effectiveness.

Discussion

The "no frills" approach to lesson production was implemented to create efficient lessons quickly: that is, lessons that presented the material concisely and without elaborate diagrams or lengthy discussions. However, some of the lessons examined in the individual reviews had elaborate, slow-to-appear diagrams. The presence of such schematics would seem to deviate from the ISD philosophy; this is especially true since comprehension of the diagrams seemed unnecessary for successfully completing the final exam.

The lean approach philosophy carried over to the area of remediation for incorrect answers on individual questions as well as the end-of-lesson test itself. In these cases, no special help units were constructed but the student was merely forced back through material he had already seen in order to hopefully comprehend it the second time around. The amount of space required for the lesson to be studied on-line would remain the same when this type of remediation was used. Because implementation of this technique reduced or at least did not worsen the computer storage problem, it was a favored approach. More important, it did not require the creation of new material and was thus quicker and more efficient than constructing additional help units.

Examples of a deviation from the lean approach have been documented (Klecka, 1977a). Occasionally, text was presented which was not tested directly and thus did not fall within the lesson objective of passing the MVE. Conversely, the lesson objective, being very broad, implied that a vast amount of material would be covered. In actuality, only the briefest introduction to the subject was presented. Thus, adherence to this philosophy of lesson construction was not universal.

Summary

In theory, the lean approach sounds very appropriate for implementing Air Force technical training: to give the airman the minimum but adequate amount of preparation for the actual field experience where he will really learn his job. In practice, Chanute authors found it hard to follow that approach rigorously and hence some aspects of the lesson materials varied in emphasis and adherence to it. Nevertheless, scattered individual reports from other bases (e.g., personal interview) have indicated that the current level of CBE training is probably adequate for basic preparation of the airman. Field evaluations indicate average or above average results (Dallman et al., 1977). However, it does not follow that this was due either to rigorous or relaxed applications of the widely-publicized lean approach.

ISD Role in Lesson Production

Initial Involvement

At Chanute during the period covered by this study (mid '74 to mid '75), the Instructional System Development (ISD) group directed the process by which the CBE lessons would be prepared. This group had primary responsibility for a developmental process known as the "front-end analysis". It consisted of the following elements:

1. preparation of a task analysis, a specialized process which encompasses describing and analyzing the job tasks in order to determine appropriate training (Department of the Air Force, 30 January 1974);
2. determination of skill levels for performing the required task(s);
3. preparation of the lesson objectives;
4. creation of criterion tests to check the performance level of the students.

The PLATO authors were not involved in the preparation of the analyses nor in the composition of the component parts.

Initially, the ISD staff believed that the PLATO author staff was sufficiently qualified and experienced that a further breakdown or guidelines for either subject matter or instructional design would not be needed. Indeed, ISD estimated that materials could be produced within a range of 50 man-hours/contact-hour of instruction (early interview with project head) to 100 hours/contact-hour (Dallman, 1974, p. 2). These estimates were made despite the fact that a preliminary expenditure of 445 man-hours/contact-hour (Green, 1973, p. 27) was required to produce a rough draft and 650 hours/contact-hour to produce a finished lesson (Main et al., 1973, p. 38-j). Similarly, it was known that Aberdeen

required slightly less than 300 hours of effort for each contact hour of material produced (Dare et al., 1975, p. 85).

In the preliminary stages of the project, the author staff may have been especially critical of the ISD prepared materials for two reasons. First, because the authors had not taken part in the front-end analysis and because of limited communication between the groups (e.g., separate offices), the authors proceeded on the basis of the documentation furnished by the ISD staff without the background and rationale behind those documents. Second, the ISD staff expected to achieve a dramatic speed-up in lesson production by eliminating some of the styles, habits, and strategies which authors found interesting and motivating, but which ISD found unnecessary.

The lesson objectives were also prepared in advance for the authors. These usually consisted of a standard approach toward the material in the lesson (i.e., "without reference, identify basic facts and state general operating principles of _____"). This goal had to be satisfied by passing an end-of-lesson test with an 80% or higher score. The striking similarity in the format of the objectives within different lessons lies in their common origin with the ISD group and the people in charge of the vehicle course itself. The authors were provided with only the general topic of each lesson. They had few guidelines about the breadth and depth of the coverage desired. Even the end-of-lesson tests were an imperfect guide to preparing the lesson; they only sampled the lesson content.

Subsequent Revisions

The authors asserted that the material presented to them by ISD was very incomplete and unsatisfactory. This was especially apparent in the

lesson objectives and end-of-lesson tests: it was the considered opinion of the authors that these components were not sufficient as guidelines for the preparation of lesson materials. In view of these complaints, the ISD staff reversed its assumptions and took a rather conservative view of the authors' subject matter expertise and instructional design experience. The following major revisions were subsequently made in the method of operation:

1. the end-of-lesson tests (the master validation exams or MVE's) were rewritten by ISD or in some cases rewritten by the authors and approved by ISD or vehicle course personnel;

2. teaching points, a more detailed outline of what the lesson contained than presented by the lesson objective, were furnished by ISD to the author staff; and

3. subject matter experts (SME's) were brought into the project to lend their expertise to preparation of lesson materials.

Thus, delays caused by insufficient input from ISD to the author staff ranged from a few days to a few weeks. These delays came at the commencement of lesson development, a crucial period for the author staff (Misselt, 1975, p. 6).

The ISD distillation of raw material was not without its benefits for the authors. They were presented with some of the material which they could shape and mold according to their specific inclinations. That is to say, the authors did not have to "start from scratch" (always a painful procedure) but had something to work with right away (i.e., the teaching points). Nevertheless, the authors were more highly constrained in the modified relationship to the ISD staff and raised objections about certain ISD components (i.e., the MVE's mentioned above). Overall however, the

ISD group provided structure and organization in this area of nascent CBE development.

There was also some feedback from the ISD group during and after the lesson writing stage. The ISD personnel would suggest adding a question here or there. Their comments reinforced the basic ISD strategy of producing lessons: lessons were to be composed of narrative portions with a few questions interspersed somewhat at random. At the end of the lesson the student would take a test to see if he had met the objective. Thus, the ISD group offered mainly minor additions or changes rather than radical instructional strategy modifications.

Summary

It can be seen that the ISD group offered the authors a starting point for the composition of the materials. What emerged typically was a lesson whose outline (i.e., the objectives and "teaching points") was determined by the ISD personnel but with the majority of its specific aspects being created by the author with input from course staff. Either because of time constraints or because of statements and suggestions from the ISD staff, endeavors requiring initial time investment for potential long-term payoff were not investigated.

The ISD group concentrated on a low-risk, low-potential-gain method of operation. This approach was probably justified by the project objectives and the history of the site. A knowledge of that history aids the understanding of why lessons produced at Chanute are, in general, not "flashy" or "clever", but nondescript and methodical. The creativity of the authors may have been limited by these constraints; in addition, no radical modifications to the basic ISD starting point were permitted due to their ostensible cost-consciousness.

Transfer of Programmed Instruction Techniques to CBE

Influence

The writing of CBE materials at Chanute followed the traditional approach toward lesson development: that is, the pedagogical strategies of programmed instruction (PI). Specifically, the structure of the lessons tended to be linear in construction with little branching to optional or helping units. Also, the use of graphical displays was somewhat limited, consistent with the adoption of the lean approach to production.

For the most part, the individual lessons shared a common format consisting of the following elements:

1. statement of the objective;
2. text portions with limited interaction;
3. end-of-lesson test (master validation exam or MVE).

As mentioned previously, ISD influence was most strongly felt in the construction of the objectives and MVE's; however, there was little control on their part for the textual portions of the lesson. The ISD staff merely indicated that the text be tailored to the subject matter of the lessons, but it was up to the individual author to design these sections.

An additional factor encouraging the utilization of the PI format may have been the limited knowledge that some of the authors had in the use of various TUTOR language commands. Fewer and simpler commands (i.e., -at-, -write-) would be needed for a linear lesson with little branching. Also, the limited use of "hints" after an incorrect answer in the programmed instruction approach may have lent itself readily to incorporation within the "bare-bones" framework. There was little incentive

to provide extensive remediation sequences either after an incorrect response was given or in a separate help unit.

Discussion

The above considerations have validity, particularly in terms of producing a large quantity of instruction while minimizing costs. However, it must be pointed out that the PLATO system offers many capabilities for presenting instruction in efficient and effective formats that have not been explored at Chanute. Individual branching for remediation or extra information has wide application for improving the effectiveness of the instruction. Specific answer contingencies for pre-determined incorrect responses can also be used to provide the student with appropriate remediation. Immediate knowledge of results on end-of-lesson tests can give the student helpful feedback on his level of proficiency. Hence, Chanute's implementation may be described as attempting to achieve cost-effectiveness by holding development costs to a minimum, rather than by greatly reducing the training needed by use of elaborate pedagogy or student management strategies.

Effect on Attitudes

Special Purpose Vehicle Maintenance instructors were asked for their views on the results of using various forms of instructional aids (i.e., visual, PLATO lessons, study guides/workbooks, lectures, laboratory, and programmed instruction). Although the survey was limited to a small database (17 respondents), it may be informative to consider their feelings on PI. Most of the respondents disagreed with the statement "I get very good results using programmed texts"[1] (average: 3.89 on a 0-9 very

[1]For data and results of the questionnaire, see Dallman, et al., 1977.

strongly disagree - very strongly agree scale). They were non-committal on the PLATO lessons (5.55). The standard deviations for the above items were 2.14 and 2.15 respectively.

Summary

It is of course obvious that few techniques such as extensive hints or remediation sequences have been explored in the Chanute lessons even though little extra effort would have been required. The heavy reliance on tried-and-true, even stereotyped, training techniques precluded this utilization. The limited skill of the authors with the TUTOR programming language may have been another factor. However, the restrictive influence of the programmed instruction format was probably instrumental in the limited employment of selected PLATO system capabilities.

General Method of Lesson Production

A variety of organizational structures have been used in PLATO courseware development, and many groups have altered their structure in keeping with shifting goals at various points in their project's history (Mahler, et al., 1976). Such was also the case at Chanute. In the early phase of the project, the authors worked independently on lessons in their own area of content expertise and instructional experience. In this mode there were no guidelines for a common instructional strategy and the authors had considerable freedom in developing their individual styles. Each had responsibility for content and lesson strategy as well as the actual TUTOR coding. This mode of operation can be considered the "individual approach".

Later, when the project goals changed to encompass development of CBE materials as part of an extensively revised curriculum, it became obvious to the new project director (the head of the ISD staff) that a restructuring of the PLATO authoring group was required. In the first place, it became necessary for some authors to develop materials for content units that they had not taught previously and in which they had had no special training. Hence, their subject matter expertise was not broad enough to include these newly assigned areas. Secondly, the ISD leader and his staff were not comfortable with the instructional strategies evolved by the individual authors. This concern was due in part to the inexperience of the ISD team with CBE as a medium and, more importantly, because elaborate strategies were not required for the limited objectives and fundamental nature of the content planned for the new curriculum. The ISD group

wanted to work with "proven" strategies rather than "experimental" ones.

To overcome the twin deficiencies of specialized content expertise and instructional design philosophy and training, the project director instituted a "team" approach to development of the required materials. This approach is described in the following section. It is contrasted with the individual approach, used extensively at an early stage of the project and also concurrently with the team approach in some instances.

Team Approach

For a major portion of the project effort at Chanute, a variety of team approaches was considered an optimum way to produce the most efficient and maximum number of effective CBE lessons. Although several authors had previously been instructors in the vehicle maintenance course for the bulk of the period during which most of the PLATO lessons were produced, the production managers for the PLATO lessons assumed, when it came to curriculum development, that the authors themselves had little subject matter expertise and less instructional programming experience. An instructor may have taught a specific block of instruction several times, but he might know very little about the material in other blocks. The authors were all recent instructors, but were not experts in material for all topics for which they wrote lessons. In this view, the main thing that the authors could provide was a facility, albeit a limited one, in the TUTOR programming langugage.

To remedy this deficiency, the following tri-partite organization was suggested for a typical production team.

1. An instructional designer, ISD staff (part-time), who acted as a resource to:

   a. aid authors who voluntarily sought him out; and

   b. review lessons and eliminate non-essential information.

2. A TUTOR author or programmer, PLATO staff (full-time).

3. A subject-matter specialist (SMS), course staff (part-time), who acted as a resource to:

   a. provice content for the programmer; and

   b. provide subject matter expertise for the authors.

In addition, other course instructors (not assigned to the project) were also consulted as well as reference books, old manuals, and other related materials. This organization was necessitated by the belief that one person alone could not contribute all the expertise and experience needed for effective and efficient lesson production.

The operating principle was that this method would succeed in producing lesson material and in time the organization could be modified. The TUTOR author could gain some of the instructional programmer's expertise as each could learn from the other. In fact, it was believed that the author and instructional programmer could produce lessons independently of each other, but there would always be a need for an SMS to assist both. There are several subject-matter areas within the vehicle maintenance group that would necessitate individual specialists in these areas on a continuous basis. In addition, the various SMS's could not learn the TUTOR language quickly enough to be efficient at lesson production in their individual areas of content expertise.

The lessons were reviewed both while in-progress and also after a first draft was completed. Usually an SMS examined it for accuracy of content, although in an interview, a former staff member commented that occasionally two SMS's would disagree on the "correctness" of a particular point. The lessons were also reviewed by other members of the group; these "peer reviews" were viewed positively for their contribution to improving the materials, according to former Chanute authors. Reviews by "outsiders" (i.e., MTC, AFHRL) were considered to have little value, since it was believed that the external reviewers would not be aware of the problems and constraints under which the authors had to work.

Independent Approach

In no sense were any of the authors fully independent of other members of the Chanute PLATO project or the vehicle course personnel. Subject matter specialists and/or other staff members had to be consulted from time to time for assistance in coding or composing particular sections. However, as the author gained familiarity with the subject matter and the TUTOR language, there was a natural tendency to become less reliant on others and more dependent on oneself. An additional factor might have been the desire to increase the production rate of the lessons or even try out more individualized approaches to lesson construction.

Summary

Since precise data on rates of lesson production were not kept, it is difficult to evaluate the success of the group/individual approach in cost-effectiveness. However, according to former authors at Chanute who were interviewed, the group approach had some merit and proved to be a

viable mode of operation. In theory, it brought together the instructional designer, the computer programmer, and the subject matter specialist to pool their resources. In practice, not all members of the team contributed equally, and thus one or more members had to work somewhat independently in order to produce a draft version of the lesson.

Conclusions

The instructional strategies and managerial techniques of the ISD staff were successful for increasing the lesson production rate to a level so that materials for the entire vehicle repair course could be produced in the allotted time with the existing staff. Management by ISD caused a restructuring of tasks, procedures, and roles into a team-oriented production staff. Instructional design by ISD meant curtailing experimental approaches and adoption of standard strategies and techniques. By introducing the lean approach and enforcing the rule of "no new strategies, no new hardware", both a floor and a ceiling were placed on the potential successfulness of the final product. Specifically, because familiar, PI-like traditional teaching techniques were employed, the instructional materials had very little probability of failing to teach adequately and were also very unlikely to produce sweeping gains in performance, retention, attitude, or time savings.

Although departures from the ISD techniques and guidelines can be found, in general the materials follow this conservative philosophy. Though some decisions about lesson design seem to have been made on the basis of expediency rather than ISD principles, the resulting training course has nevertheless met its objectives.

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Chapter 2: Computer-Aided Management at Chanute

Abstract

The purpose of this study is to examine one organization's efforts to reduce the time and cost while improving the effectiveness of various management functions by using the PLATO IV computer-based education (CBE) system. The site selected for this study was Chanute Air Force Base, whose PLATO project staff made extensive use of the data collection and retrieval, student records, and other available resources of the computer system. The data collected included student test scores and specific responses to individual test questions. The need for such data collection and management of student performance scores has been previously pointed out. This report was submitted in draft form to Chanute PLATO staff for their comments and suggestions.

Introduction

The purpose of this study is to examine one organization's efforts to reduce the time and cost of various management functions in a military training environment by using the PLATO IV computer-based education (CBE) system. The site selected for this study was Chanute Air Force Base, whose PLATO project staff made extensive use of the data collection, student records, and other software resources of the CBE system. The data collected included student test scores and specific responses to individual questions. The need for such data collection and management of student performance scores has been previously pointed out (Dallman, 1975a, p. 53).

In order to gather data for the Service Test of PLATO IV at Chanute, the Training Research Applications Branch (TRAB) and the instructor personnel in the target courses administered pre- and post-tests, recorded student block grades, remedial instruction time and washback rates (Dallman, 1974, p. 4). Since the completion of the data collection for the Service Test, similar course management activities have been carried on by the reorganized PLATO authoring staff in cooperation with course instructors. The capabilities of the system have been used in order to make data collection and management more efficient and to ease the burden of the instructors from time-consuming tasks.

The intent of this report is to describe the management applications of PLATO at Chanute. Chanute's techniques are not presented as an optimal way to utilize all system data-related management capabilities but as an example of one site's initial efforts in this area.

Selected Capabilities of the PLATO IV System

The PLATO IV CBE system has many capabilities for data collection and retrieval that can be employed by the average user. Like any advanced computer system, it can manipulate databases to provide information for decision-making or record-keeping. It is especially convenient to use the system to monitor or manipulate information that is generated by on-line student use (e.g., test scores, responses to interaction, accessing of "help" sequences, etc.). The collected data are available when needed by the instructor to monitor the student's progress and/or detect the need for remediation.

Figure 1: MVE Times and Grades

	tomvel							
STUDENT NAME	TIME	GRADE	TIME	GRADE	TIME	GRADE	TIME	GRADE
anderson	4	75	2	80				
blake	11	100						
cole	7	90	3	85				
corman	9	100						
flynn	7	85						
harris	5	75	2	60	2	75	1	100
kelly	6	95						
murdock	8	75	5	100				
ostrowski	4	85						
stewart	7	95	3	100				
thompson	5	85						

Utilization of System Management Capabilities

Monitoring Student's Progress

Data, including scores on tests and individual responses to test items, have been collected for students in the Special Purpose Vehicle course. In addition, data have been collected for students in the General Purpose Vehicle course. For the latter course, the data were of a longitudinal or chronological variety and also included course completion times and bi-weekly tests known as block exams.

Chanute PLATO author staff created programs to collect and display a variety of student performance data. In the on-line student roster (maintained on the PLATO system), the student is listed by last name, and the scores on the master validation exams (MVE's) are recorded along with the amount of time that the student needed to finish each test (Figure 1). The number of minutes needed for completion of the MVE is important since it probably indicates the student's level of knowledge and rate of progress as well as showing the instructor which students are having difficulty with the material. That is, a long completion time and a low score may indicate the need for remediation or at least consultation with the student to ascertain a possible problem with comprehension, while a fast completion time coupled with a high score suggests some proficiency in that area.

While collecting the student responses and grading the test, the computer implements the scoring formula or "correction factor" in use at Chanute (total score = [number correct] - [1/4 × number wrong]). Thus, the mathematical grading functions that would have to be performed manually by

the instructor can now be performed much more rapidly and accurately by the computer. In addition, student data can be stored for selective retrieval by the instructor or student: the instructor can use the data to determine the student's level of proficiency and the student can monitor his own progress and/or need for remediation. In addition, the test itself may need to be modified based on the results of student data collection. That process of test modification is discussed in a later section.

Information Storage and Retrieval

The data that are collected are easily accessible to instructors and/or their supervisors. The options available in the Chanute information retrieval package are listed on the index page of the program (Figure 2). A permanent record of the desired data can be produced by means of the Varian copier (a device attached to a PLATO terminal to record images from the screen display) in the authors' office at Chanute. The number of instructor and/or supervisor comments relating to questions on the tests is listed (Figure 3). The comments can also be accessed by the instructor or supervisor from the same information retrieval package.

The information required by Air Force Form 668 for recording test scores has been placed on-line (Figure 4). The responses from the students are now recorded automatically after they take a test and the form is filled in without the instructor's intervention. The effort needed for what was once a "time consuming clerical function" (Dallman, 1975, p.53) has been reduced from about an hour to

Figure 2: Test Times and Grades

INDEX

Choose one »

a) UPDATE
b) LESSON TIME - copy
c) MVE TIME/GRADE - copy
d) BLOCK TEST - copy

Info on last update

Data file name: spdata
Date updated : 01/01/76
Time updated : 12.43.29

The date is 01/05/76 The time is 15.25.30

Figure 3: Instructor/Supervisor Comments for each Test

TEST #	# TIMES ADMIN	# INSTR COMM	# SUPV COMM
111	2	2	2
112	6	5	4
113	4	4	4
211	2	2	2
212	4	4	4
213	3	3	3
311	6	4	4

Figure 4: On-Line AF Form 668

Class # 760414ad 11 Students

Test # t113

	incorrect responses				correct answers
	a	b	c	d	
1	3	0	0	0	b
2	0	0	0	2	c
3	0	0	0	0	a
4	0	0	1	0	b
5	0	0	0	0	d
6	0	0	0	0	c
7	0	0	0	0	a
8	0	0	1	0	d
9	0	0	0	0	b
10	0	0	0	0	a
11	0	1	0	0	d
12	0	0	0	0	c
13	1	0	0	0	b
14	0	0	0	0	d
15	0	1	0	0	d
16	0	0	0	0	b
17	0	0	0	0	c
18	0	1	0	0	a
19	0	0	0	0	a
20	2	8	0	0	d

-DATA- for another class

-LAB- for composite

-SHIFT LAB- objectives

-NEXT- choose another test

10-20 minutes.[1] Since approximately 7 tests are given during the 6-week course by each of the 11 instructors and 12 of the 29 tests included in the course have thus far been put on-line, the time saved can be calculated as follows:

$$\frac{7 \text{ tests}}{6 \text{ weeks}} \times \frac{12 \text{ tests}}{29 \text{ tests}} \times \frac{50 \text{ min}}{1 \text{ avg test}} \times \frac{1 \text{ hr}}{60 \text{ min}} \times 11 \text{ instructors} \approx$$

$$4.5 \text{ instructor-hours/week}$$

Thus, a total of more than 4 instructor-hours per week has been saved. If all tests were on-line, a total savings of approximately 9 man-hours per week could be projected. The net savings in dollars is difficult to calculate since it is not known how many hours were required to produce the original data collection lessons. Nevertheless, the benefits resulting from the utilization of such lessons are significant and widely applicable.

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[1]The larger saving was estimated by the instructors, while the more conservative estimate is found in the PLATO IV Data Automation Requirement (DAR) endorsed by Major General Edwin W. Robertson II, on 9Aug76. Department of the Air Froce, Headquarters Chanute Technical Training Center (ATC), Chanute Air Force Base, Illinois 61868. Sec. 2.g. (3).

Specific Applications of Data Management

Author Mode: POI Editor

At one point in the project, it was believed that plans of instruction, (POI's) outlines for teaching a particular segment of material, were subject to a series of rapid, yet relatively minor format changes. Although the re-typing and reprinting times could barely keep up with the changes, the obligation to have an up-to-date copy of each POI remained. In an effort to satisfy this requirement, work on an on-line programming routine (an "editor") to effect these changes was commenced. One of the Chanute author staff was given the task of creating such an editor which would allow POI's to be changed with minimal effort.

A study of the potential cost savings of the POI editor was included as part of the contract for which this report is being produced (CERL, 1975, p. 38; also Dallman, 1975b, p. 3). However, after the form of the contract was finalized, the Chanute development effort was abandoned. Under normal conditions, the POI's are only changed on the average of once a year, and consequently the need for such an on-line capability would be limited. Though it was decided that work on the editor be suspended before a fully operational routine was achieved, it should be noted that enough work had been done so that it was possible for this evaluator to prepare a working editor after some minor empirical testing.

Student Mode

Storage of student answers. An expanded version of a student test data collection package written at Chanute includes a listing of all responses for each question on a test (Figure 5). According to Air Force

Figure 5: Listing of Test Item Responses

Class# 760203ac									Class average 91%							
#Students 5																33
t113	# Wrong items						Total		Gra							
	1	2	3	4	5	6	Wrong	Right	de	1	2	3	4	5	6	
# 1	2	8	2	3	0	0	15	18	100	0	0	2	1	1	1	3
# 2	0	1	3	2	1	1	6	27	95	4	4	1	3	0	0	12
# 3	0	0	2	0	0	0	2	31	90	1	4	1	4	0	0	10
# 4	0	0	4	1	0	0	5	28	85	0	0	4	2	0	0	6
# 5	0	0	0	0	0	0	0	33	80	0	1	0	1	0	0	2
# 6	0	0	0	0	0	0	0	33	75	0	0	0	0	0	0	0
# 7	0	0	0	0	0	0	0	33	70	0	0	0	0	0	0	0
# 8	0	1	0	1	0	0	2	31	65	0	0	0	0	0	0	0
# 9	0	1	0	0	0	0	1	32	60	0	0	0	0	0	0	0
# 10	0	0	0	0	0	0	0	33	55	0	0	0	0	0	0	0
# 11	0	0	0	1	0	0	1	32	50	0	0	0	0	0	0	0
# 12	0	0	0	0	0	0	0	33	45	0	0	0	0	0	0	0
# 13	0	1	0	1	0	0	2	31	40	0	0	0	0	0	0	0
# 14	0	0	0	0	0	0	0	33	35	0	0	0	0	0	0	0
# 15	0	0	0	1	0	0	1	32	30	0	0	0	0	0	0	0
# 16	0	0	0	0	0	0	0	33	25	0	0	0	0	0	0	0
# 17	0	0	1	0	0	0	1	32	20	0	0	0	0	0	0	0
# 18	0	1	0	1	0	0	2	31	15	0	0	0	0	0	0	0
# 19	0	0	0	0	0	0	0	33	10	0	0	0	0	0	0	0
# 20	4	3	3	10	0	0	20	13	5	0	0	0	0	0	0	0

regulations, the instructor and his supervisor are required to give a written explanation for any question on a test that is missed by all the students, none of the students, or answered with the same response by all the students. When the PLATO system is used for collection of individual item responses, the instructor and his supervisor have all the information readily available to make a diagnosis of the above problems.

Data gathered in an analysis of materials produced at Chanute also suggested that the test item responses were in fact used for formative modifications: that is, the test questions were revised to make them easier to understand. For further information, see the section on "Tests", and Appendix II in Klecka (1977).

Storage of instructor comments. The recording and storage of the instructor comments have also been automated (Figure 6). After noting one or more incidents requiring analysis and commentary, the instructor can advance an explanation for the actual student responses. Then the supervisor, before making his own comments, can review the actual question(s) along with the observed breakdown of the responses. These remarks are then stored and are made accessible to both instructors and other supervisors. Both sets of comments can be used to modify the test question(s) if such action is deemed appropriate.

All the data necessary for making a comment are readily at hand. The comments themselves take the form of a brief phrase or two giving a suggested explanation for the particular phenomenon that occurred. Much time is saved in making these comments since the individual test papers need not be drawn from one file and the comments selected from another file. All can be viewed in a few minutes without the instructor leaving the

Figure 6: On-Line File of Instructor/Supervisor Comments

Class number / 760204
Instructor / blake
Date / 05/05/76
test was reviewed and considered
valid. 60% of the
class missed question 20 seems
they were confused with
the source of the oil
flow rather than the path of
oil flow. test was
critiqued in class.

Class number / 760204
Supervisor / rogers
Date / 05/05/76
material pertaining to question 20
is well covered in plato
lesson. question is valid.

terminal. The savings in time and effort of limited manpower is considerable since this review is a mandatory process, but it is not easy to estimate precisely how cost effective the new computerized system is. Furthermore, the review process has been improved, in the opinion of the Chanute instructor staff, because the presence of both data and comments in an easily accessible format encourages and facilitates a more thorough evaluation.

Retrieval of data and use. According to Chanute staff who were interviewed, the instructors have accepted computerized data collection. At first, when they did not adequately understand the sytem or perhaps felt their jobs were threatened by it, the instructors apparently were not very enthusiastic. However, after they saw how their time could be better spent on individualized help for their students and how much more accurate the PLATO IV system could be, their own experience convinced them of its effectiveness.

The reliability of the old manual system of recording data is not known precisely. However, it was widely regarded by the Chanute staff as a very laborious precedure: the results of block tests with 30 questions each and 5 categories of possible answers ("a" through "e") for 11 students per class had to be transcribed. Alternatively, when the instructors interacted directly with the computer, the necessary procedures for utilizing the data collection routines were seen to be quite straightforward and less tedious than the manual method of inserting numbers into a long AF form.[2]

On-line lessons were also used to maintain an up-dated status report on courses undergoing revision by the Instructional System Development (ISD)

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[2]This was reported by PLATO project authors who trained the instructor staff in the use of these routines and also provided a special lesson ("chahelp") as an on-line aid to the various data collection procedures that were available.

group (Figure 7). Projected dates were given for the work, or the course was marked as completed when it was done. Thus, a continually updated picture of the status of the course could be maintained and easily accessed. The instructors concerned could be kept abreast of any developments related to their courses.

A pre-test has been put on-line so that prospective students can be ranked approximately according to their probable achievement in technical areas ("cha93"). At one time a paper version of the pre-test was used for five courses (25-30 students per month) in the Department of Weapons System Support Training to give the instructors an idea of what types of students would comprise each new class. The test seemed to work well for students in the vehicle training courses, but for students in other disciplines such as airframe maintenance, it did not adequately reflect the likelihood of their success.

The pre-test shows a definite vehicular orientation, and this may have been a cause of its limited validity when used for other courses. The pre-test is now administered only to vehicle maintenance students. Here too, the scores are stored and referenced by surname while the students are given an aptitude level for the following areas: general, mathematics, vocabulary, easy and hard technical.

In all these areas of test administration, the different routines collect and store the data until the results are needed. In addition, the files (i.e., storage locations on computer's magnetic disk) can be cleared out to make room for new lists of students when the instructors decide to update them. The procedures for entering a new class and reinitializing the data storage bank appear to be simple enough tasks so that the instructors

Figure 7: Status of Courses under Revision

		TWSV	05/07/76
1.	2ASR47251 -81	Sep 76	104 hrs
2.	2ASR47251B-3	May 76	80 hrs
3.	2ASR47251C-1	Dec 76	0 hrs
4.	3ABR47230	Sep 76	550 hrs
5.	3ABR47231A	Comp	640 hrs
6.	3ABR47231B	Comp	480 hrs
7.	3ABR47000C	Comp	360 hrs
8.	3AZR47251B-1	Jun 76	80 hrs
9.	3AZR47252 -1	Dec 76	240 hrs
10.	3AZR47252 -2	Dec 76	104 hrs
11.	3AZR47252 -3	Dec 76	120 hrs
12.	3AZR47252 -4	Dec 76	40 hrs
13.	3AZR47252 -5	Oct 76	40 hrs
14.	4AST47250 -1	Sep 76	80 hrs
15.	4AST47250 -2	Dec 76	0 hrs

Explanation

ABR = airman basic resident (a beginning course like the GPV and SPV courses).

ASR = temporary course for 3, 5, or 7 skill levels (journeyman or advanced).

AZR = permanent course for 3, 5, or 7 skill levels (journeyman or advanced).

do not need assistance from the project staff, according to the staff members consulted in an interview. In this application, the computer allows a new service to be provided expeditiously. Unfortunately, no cost savings is calculable. Presumably, the effectiveness of the instructors is enhanced by early diagnosis of students' potential problems. The above views are based on lengthy interviews with the instructor staff at Chanute.

Conclusions

During the planning stages of the project, Chanute staff found only limited management applications for the PLATO system. The capabilities of the computer became more significant for handling the substantial amount of data collected during the formative development period. As the project matured, the computer assumed a larger role as the data-keeper for managing students or information about students.

A precise cost/benefit analysis is difficult because many computer applications allowed an improved quality to be achieved for a task which had no criteria. For example, the existence of readily available data collection and management routines permitted and encouraged more careful analyses before making decisions. Although "better decisions" are certainly a desirable goal, it is difficult to determine a reasonable cost for them in concrete, dollars-and-cents terms. In other cases, there is no clear-cut way to compare the accuracy of computer-tabulated data against previously unaudited entries or to assign an economic value to the (presumably) more accurate data.

In any event, the use of the PLATO system at Chanute for testing and data management was significant for the following reasons:

1. it freed the instructors from tedious, time-consuming tasks to give more attention to helping individual students;

2. it reportedly improved the accuracy in recording specific responses to questions as well as the test scores themselves;

3. it allowed rapid and convenient access to relevant data for instructors and their supervisors who had need of the information;

4. it made retrieval of the actual test items as well as the results of the tests readily accessible on-line.

Summary Tables

For the convenience of the reader, observations related to the detailed data presented in the tables are given below.

1. The number of lessons used for data collection and testing of students as well as the number of times they are accessed indicates such use was of substantial importance to the operations of Chanute: from October 8, 1975 until October 1, 1976 these programs were used for over 800 hours.

2. The amount of time originally expended by the authors in the preparation of these programs is difficult to determine since exact figures on production rates were not kept; however,

3. The Chanute staff indicated that approximately one month was spent preparing the revised forms of those programs with old and new versions described in the appendices.

4. Student response data has given authors guidance for modifying and improving tests.

5. The Chanute author staff is continually working to improve the data collection routines by streamlining the programs to enable more efficient coding and thereby reduce ECS usage.

6. Efforts to improve the data collection routines indicate that these programs are considered useful for the instructors and students, as well as the author staff.

Tables of Selected Test and Data Management Files

Introduction

The following are descriptions of PLATO programs used for the collection of student responses to questions and scores on tests at Chanute as well as sample tests themselves and other data collection programs. Some comments on them are given, as well as the amount of space (ECS) needed, a factor involved in their utilization. Furthermore, in several cases, there is an old version of a program that has been or is being phased out by a newer improved version requiring less space. Data are given for both versions in those cases. Readings were taken on September 15, 1976 except where another date is indicated.

Explanation of Terms

1. High ECS = over 10,000 words

   A large space requirement would tend to make it difficult to use the lesson between 10:00 a.m. and 3:00 p.m. on weekdays when the system-wide demands for ECS are greatest.

2. Usage: number of times lesson has been accessed and the amount of time spent in the lesson since it was created or since October 8, 1975 when accounts data keeping was begun.

3. Non-Chanute: usage of lessons at other sites such as Parkland College in Champaign.

Table 1: Test Item Response Collection

Program: spshred668 (formerly "cha25")
ECS = 8065 (formerly 11595)

Subject matter: AF form 668 - item analysis for test evaluation.

Usage:

	Uses	Hours
Total	3752	502.8
Chanute	3138	464.0
Non-Chanute	219	38.8

(Figures on usage as of September 20, 1976.)

Program: cha95
ECS = 6392

Subject matter: MVE results from datafile: daily appraisal of end-of lesson test results.

Usage:

	Uses	Hours
Total	274	16.2
Chanute	55	2.2
Non-Chanute	219	14.0

Program: cha139
ECS = 7163

Subject matter: Block and pre-test scores and analysis pre- vs. post-test scores.

Options:
1. update file
2. student data and test data
3. block averages

Observation: The figures for "cha139" are as of August 1, 1976. Deletion of this program occurred after that date since it had had limited use, according to Chanute staff who were consulted on September 17, 1976.

Usage:

	Uses	Hours
Total	165	6.2
Chanute	4	.1
Non-Chanute	161	6.1

Table 2: Student Management and Instructor Help

Program: charich (formerly "cha39")
ECS = 1500 (formerly = 3252)

Subject matter: Enrichment lesson list

Observation: The enrichment lessons were used when a student completed the assigned lesson before the time period was up. The purpose, according to one staff member, was managing students who might otherwise have wandered around the room and interfered with other students still working.

Usage:

	Uses	Hours
Total	2244	60.9
Chanute	2194	57.2
Non-Chanute	50	3.7

Program: cha93
ECS = 5334

Subject matter: Pretest to determine student aptitudes in various areas.

Options:
1. all students' scores
2. weak students' scores by area
3. total test analysis
4. individual students

Usage:

	Uses	Hours
Total	719	191.7
Chanute	474	180.7
Non-Chanute	241	11.0

Program: cha69
ECS = 1500

Subject matter: Special Vehicles POI Form with a sample lesson plan.

Observation: Examination of this routine revealed that no special editor was needed.

Table 2 con't

Program: chahelp
ECS = 2914

Subject matter: Orientation to PLATO use for instructors.

Options: (table of contents page)
1. introduction
2. writing test comments
3. entering students in a course
4. deleting students from a course
5. assigning modules
6. lesson sequencing
7. assigning block or shred tests
8. locating student statistics (i.e., grades)
9. notefiles (instructor and student)

Usage	Uses	Uses	Hours	
	Total	155	7.9	(all by Chanute as of October 20, 1976)

Program: cha132
ECS = 4147

Subject matter: Data on courses and ISD work.

Options:
1. data by branch
2. data by type of course
3. percent completed
4. completed courses
5. all courses
6. add new courses
7. scheduled courses
8. overdue courses and courses due next 60 days

Usage:	Uses	Hours
Total	344	17.8
Chanute	191	11.3
Non-Chanute	153	6.5

Table 3: Tests

Program: blockt001
ECS = 3250

Course: SPV **Subject:** block x

Subject matter: Sample of a typical block test (there were approximately 15 of these block tests on-line as of November 3, 1976). Questions on a variety of topics which the student had to learn by self-study outside the classroom.

Observation: Very easy for instructors/supervisors to read other comments and write their own in this lesson, even for someone with limited experience on the PLATO system.

Usage:

	Uses	Hours	
Total	14	0.7	(all by Chanute)

Program: shred511a
ECS = 3746

Subject matter: Block test for common course segment (this is a sample of 23 block tests now on-line).

Observation: Four block exams for the portion of the course common to the four shreds (i.e., the portion of the SPV for which the PLATO lesson materials were developed) are on-line and have been used. Following the six week common course segment, the students were given instruction in their own specialty in each of the four shreds. Block exams during this specialized training period are called "shred exams". At the time of the interview, all six of the "D" shred block exams were on-line and in use. They had been put up gradually, or at least not simultaneously. The "B" and "C" shreds each had two exams to go on-line right away and two more coming soon. The "A" shred had not been revised by ISD, and hence its block exams would not be on-line.

Usage:

	Uses	Hours	
Total	81	7.2	(all by Chanute)

Table 4: Test Results and Analysis

Program: spgrades (formerly "cha90")
ECS = 2524 (formerly = 3267)

Subject matter: Block test results (names, items missed, score).

Options:
1. see data by class
2. see data by test
3. see data by student
4. zero data
5. update

Observation: The above options show how easy it was to examine and reinitialize the recording of data, even for a novice instructor.

Usage:

	Uses	Hours
Total	496	16.7
Chanute	276	9.8
Non-Chanute	220	6.9

References for Chapter 2

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Chapter 3: A Survey of Chanute Lesson Development Techniques

Abstract

A survey of the process of lesson revision and development at Chanute AFB was considered important to determine its effects on the lessons and the pedagogical impact of the computer-based education materials. Eight representative lessons were selected by a Chanute evaluator. In the course of revision, these lessons were subjected to a series of modifications by Chanute staff members to insure their validation when used by military students. An MTC evaluator prepared an in-depth analysis of the "before" and "after" versions of each lesson to ascertain the changes and their impact. Evaluators at Chanute were given draft versions of the report for their comments which were included in the final version.

Introduction

Background and Objectives

This is a study of the changes made between two series of Chanute lessons: an early and a later series. The first series consisted of lessons before validation had been attempted, but after trial students had been run and after initial lesson development had been halted. The second series included these same lessons after they had undergone revision, where necessary, based on student data. The revisions were made by Chanute staff to increase the likelihood that they would validate: i.e., that 90% of the students would get 80% or better on the end of lesson test.

The objectives of this report are two-fold:

1) to examine the lessons to ascertain what changes have been made, and

2) to determine the impact of the changes on student performance.

A more thorough discussion of the individual lessons can be found in An Overview of Chanute Lessons, MTC report #10. The author assumes that the reader has read or has available that report since it will be referred to occasionally (hereafter called the Overview).

Method of Approach

These analyses compare two versions of eight lessons: one version early in its developmental process and another version which had been modified over approximately 9 months, including 6 months use by a total of about 150 students. (See Appendix I for details.) The ways in which each version differed were noted and evaluated. By this procedure some

insight can be gained into the revision process used to improve the probability of validation and into the process of lesson development as practiced in the Chanute PLATO project.

The type and quantity of changes were by no means uniform. In some cases the modifications were of minor importance, perhaps even negligible. In others there were significant structural and pedagogical remodelings. As might be expected, the latter will be explored in greater detail since they have had a greater impace on the achievement of lesson objectives. Throughout this chapter, the lessons will be referred to by a name and number, e.g., "PTO"(1) indicates the pre-validation version while "PTO"(2) indicates the post-validation version of the lesson on the Power Take-off unit.

As part of the formative development of this report, draft copies were submitted to the evaluators and authors at Chanute. Additions and corrections were included in the report at appropriate places. In addition the Chanute evaluator's comments are included at the end of this report.

Structural Analysis

General Comments

In all lessons but "PTO"(2), the structural changes did not warrant a new detailed diagram (i.e., flowchart). These diagrams (not included with this report) were used extensively for this and other Chanute reports, notably the Overview. For more details on this and other subjects mentioned here, that report should be consulted.

One observation is in order at this point. The lessons in the second series share an indexed linear format (except for "emission"(2) which is basically non-indexed). The modular approach is a later addition to the instructional design of the lessons. In most cases, the lessons are now organized in such a way that the student can choose when he is to do each section. This is an important move toward increasing the individualization of the lesson.

Specific Comments

"PTO"(1) and (2). Since the copy of "PTO"(1) available to the reviewer was not complete, the revised form, "PTO"(2), was analyzed in some detail. More extensive remarks may be made about this lesson than about the others in this series because of the lack of previous commentary.

"Starter"(1) and (2). The lesson "starter"(1) was also available only in an incomplete form. The later version, "starter"(2), while differing in many aspects from its predecessor, showed only minor structural differences. Consequently these did not warrant a new schematic; they will be mentioned in the discussion of organization ("intra-lesson"). "Starter"(1) had only a superstructure which was not filled in, and "PTO"(1) displayed the beginnings of a whole lesson; these did not possess

the usual characteristics, i.e., objective, index, end of lesson test, etc. to make it even eligible for analysis.

General Comments - Organization

Inter-lesson

"By-pass test" option. The most significant organizational change in these lessons is the elimination, in all but one of the lessons, of the option to take the end of lesson test immediately upon entering the lesson. This "by-pass" test option is now available only in "diesel"(2), and its availability may be an oversight rather than a deliberate design feature. Consequently the student must now go through the whole lesson before he is allowed to take the end of lesson (i.e., validation) test.

According to Chanute staff, this change was originally made to furnish additional validation data. It was allowed to remain after validation because it was decided that there was no advantage to saving the time of the good student in the group-paced usage. Also, students selected the by-pass option repeatedly to avoid taking the whole lesson; if they did not pass, they were cued to be especially attentive to certain portions of the lesson and may have neglected other areas as a consequence. The option was removed, rather than re-coded to allow only one attempt at the end of lesson test. Apparently few students passed the test as an option. Thus it was felt that the students' time would be better spent in going through the lesson rather than making repeated attempts at the by-pass test.

"Teaching points". A noteworthy addition to each lesson is the presence of a detailed outline available to an author (NOT a student) from the page stating the objective. This outline is much more detailed than the brief one found in the index to the lessons. In only two

lessons ("driveshaft" and "electricity") are directions given for accessing the teaching points; in the others it was discovered by an examination of the coding. The reason Chanute ISD (instructional system development) staff stated for not allowing access of these "points" was that "the student will eventually see the information in the teaching points when he takes the lesson." The reviewer feels that the usefulness of the teaching points to the student may be substantial and should at least be investigated. (See Appendix IV and "General comments: Components" of the overview.)

Other new material. In some cases information is presented in the second series of lessons that does not appear in the earlier versions. Details of such occurrences will be found in the section on "new material". The information presented in that section was not felt to be significant enough to change the organization of the lesson in any substantial way, and thus is not included in the following discussion ("General comments: Intra-lesson").

Intra-lesson

A few specifics on significant organizational changes:

"starter"(2)

The large help section of "starter"(1) has been broken up into convenient-sized sub-sections. These are listed on an index page and can now be chosen at will by the students. They can go directly to a specific topic and need not wander around in one large section as before.

The individual section pre-tests (i.e., section by-pass tests) have become end of section tests, and there is no option available for taking them in lieu of going through the particular section.

Of the eight lessons examined, only "starter"(1) contained such section pre-tests.

"transmission"(2)

The index page is more useful: it now appears at the beginning of the lesson, instead of the end as in "transmission"(1). Also the students have a choice as to when each section will be done.

"PTO"(2)

This is a very short lesson on transfer cases, sprag units, and power take-off units. Each subject area is contained in a separate module which can be taken at any time. The end of lesson test can be attempted only after all three sections have been completed.

The remaining lessons are virtually identical to the earlier versions as far as their organization and structure are concerned. In other sections within this review, specific comments will be made where the lessons differ from their predecessors.

Specific Comments

Teaching to an Objective

In all cases the objective has remained the same: to pass the end of lesson test with more than 75-80% accuracy.[1] In "starter"(2), this objective is stated, although it was not in "starter"(1). The accomplishing of the objective is based solely on passing an end of lesson test. As in the Overview, much attention will be given to the end of lesson test and to the factors affecting the student's successful completion of it.

Terminology

The Overview provides an extensive analysis of this subject. As far as the current report is concerned, "transmission"(2) is the only lesson to show appreciable changes in this category. (See Appendix VI for details.) Usually the context in which the key terms/concepts appear must still be used for explanatory purposes. There has been no significant shift in emphasis toward rigorous definition of terminology in the later series.

Interaction

In general the amount and type of interaction is very similar in both sets of lessons. However a few questions have been added or rephrased and will be mentioned because they relate to the items on the end of lesson test. Frequently the phrasing change or addition brings the question more closely in line with test items seen later. Comprehension

---

[1] However, the criterion for a lesson that was not part of the group of eight examined in this report, Engine Lubrication System, was relaxed during revision from 7 of 8 (88%) to 6 of 8 (75%).

of the questions may also be improved by this remodeling. Examples of these are as follows:

"emission"(2)

One multiple choice question has been added: it is on a topic related to the subject matter stressed in a previous question--air flow around the draft tube in a non-positive crankcase ventilating system.

The author rephrased a completed question concerning the location of the entrance point for air in the positive-open type of crankcase ventilating system. The old question, which the rephrase replaces, was very similar to a previous question. Thus the rephrased question is important because it eliminates a nearly redundant question and instead emphasizes previously unstressed knowledge.

"transmission"(2)

Four questions have been added: three of these cover topics for which there were previously no questions in the body of the lesson, but which were covered in the test. The other addition is less significant because the material it stresses is already covered by another question.

"driveshaft"(2)

A single question has been reworded so that it now relates to material in one of the test items.

"electricity"(2)

One question has been changed from an open-ended fill-in ("What would you call the smallest piece that would still be the same kind of matter?--any good guess will do)" to a rhetorical question ("What is a molecule?"). A discussion of that subject area then follows.

In general the questions added or remodeled are directly related to items on the test and apparently stress important concepts.

Visual Presentation

In the majority of cases the graphic displays and other aspects of the visual presentation have remained the same in the second set of

lessons. However a few changes can be detected:

"emission"(2)

One small change is evident in that two small phrases are underlined which stress an important component of one of the crankcase ventilating systems that is reviewed on the end of lesson test.

"starter"(2)

Frequently the text describing a slide is superimposed over the colored portion of the fiche, making it difficult to read the text. This is the case whether the old or new fiche is used. Also in some cases it is very difficult to discern what the slide is presenting: there is no lettering on the fiche indicating what is being seen. Upon reading the above comments in June/July 1976, the Chanute staff replied that they felt all such problems had been corrected by reprogramming and by production of a new fiche. However, the reviewer rechecked the lessons and found many of the problems still in existence.

"diesel"(2)

Replacement of a mediocre and tedious graphic at the beginning (i.e., something like a cross between a computer and a stock report ticker tape, perhaps an attempt at humor?) with a slide of a diesel engine. Even the author realized the impact of the original since he allowed the NEXT key to break through the plotting.

"electricity"(2)

Important terms/concepts in several units of text are stressed by the use of all capital letters.

Thus these changes appear to be perceptible attempts at heightening the visual impact of the CBE presentation.

Feedback

Some changes in feedback can be noted here:

"emission"(2)

In one unit the new material that once appeared in the feedback position, although not properly feedback, now appears in a separate unit/frame. (More details on this placement of new material in section on "feedback" in the Overview.)

"starter"(2)

Throughout this lesson the answer is given in the feedback after three incorrect tries. This enables the student to move on without halting his progress when he is unable to proceed (although this technique may encourage a careless attitude in the student and thus has some hazards).

"transmission"(2)

In one unit new material is taken from the feedback position, though it too really wasn't feedback, and put into a separate unit/frame. If new material is presented to the student at the time he is given or is expecting feedback, he may pass over it lightly and thus may miss valuable information. This seems especially likely to happen if the student has been exposed to intimidating or abusive feedback in other lessons.

Tests

The end of lesson tests are the sole criteria for accomplishing the objective in these lessons. There has been considerable remodeling of these tests, as seen in the comments below:

"emission"(2)

Two questions on the test have been rephrased for clarity. See Appendix III for more information on this subject.

"starter"(2)

The original end of lesson test in "starter"(1) has been made the end of lesson review containing seven multiple choice questions. The new test is the familiar ten-item matching drill. From a subject-matter point of view, the original test seemed more difficult and may have also been a more valid test of the objectives.

"transmission"(2)

The scoring procedure should be mentioned since it differs from that in the previous version. In "transmission"(1) the correct and incorrect answers were shown after the test was graded. Now there is no individual scoring, but the student is given refresher information on questions he missed: brief paraphrases of previously seen material or the material itself is shown again.

Then the student is taken back to the index page with specific sections marked that must be completed before he can retake the whole test. This is another variation on the forced review technique, which may be effective as a pedagogical device.

"diesel"(2)

At several places in the text there are strong hints that certain items should be remembered. Hence though the test itself has not changed, its difficulty has possibly been reduced. For more on this, see Appendix II to this report.

"drive shaft"(2)

Only two of the ten questions on the end of lesson test are the same as in "drive shaft"(1). The interaction in the lesson now follows more closely the information requested on the end of lesson test, although the content is roughly the same.

The following table is a survey of the changes made in the relationship of interaction and items on the test between the two series of lessons. The percentage indicates the number of test items that have been previously covered via interaction in the body of the lesson. For example, in the case of "starter"(2), there is at least one paraphrase question in the text for every question on the end of lesson test. It was not considered necessary to make a separate listing for those instances where a question on the end of lesson test was anticipated by more than one question in the body of the lesson. The benefit was thought to be problematical.

Related observations. In the reviewer's opinion, the reading ability, difficulty of questions, length of lesson, etc. may have an important effect on the performance of the students: e.g., "driveshaft"(2) is very brief (about 20 frames). Thus even if the percentage is not high, the student may do better than expected if the same material

Table 5

Percentage of Test Items Covered via Interaction

Lesson	Version(1)	Change	Version(2)
emission	40%	+30%	70%
starter	20%	+80%	100%
transmission	40%	+50%	90%
diesel	30%	+20%	50%
hydraulics	100%	0%	100%
drive shaft	40%	+30%	70%
PTO	--	--	40%[a]
electricity	85%	0%	85%

[a]This includes one question on the test not covered at all via interaction or text. Examination of the test results shows that the performance of the students on this question was about the same as their performance on other test questions!

were embedded in a longer lesson so that short-term retention would not be the main factor in performance on the test.

It should be mentioned that this is not presented as any definitive judgement on lesson quality. It is likely that the questions on the end of lesson tests were modified in an attempt to make them easier so that students could pass the tests and the lessons would validate. Also the reviewer has no way of determining what was considered prior knowledge for the students in going through the lesson. Thus some terms and/or concepts may be familiar to the class and may not have been stressed due to this prior exposure. Consequently the students could answer the test

questions even without their being pre-tested. In this way, factors outside the boundaries of the lesson may play an important role in the success of the lesson as a pedagogical whole.

Coding

Major problems.

"drive shaft"(2)

> On the index page, if a student presses any key other than the ones allowed (i.e., a, b, c, d, e,) an execution error occurs: the student's progress through the lesson is interrupted and he is summarily deleted. This error was NOT present in "drive shaft"(1)!

Minor problems. Some minor problems were discovered in the course of preparing the individual reviews. In general, it is the policy in this report to list only changes that have been made from the previous series. However in this section on coding, uncorrected errors are significant since they may affect student progress through the lesson. Thus they will be noted here when they have been passed on unchanged from the early version. A more extensive description of coding problems in general in the Chanute lessons is available in the Overview.

Specific examples.

"emission"(2)

> There is only partial erasure of a question when forced review is done for an incorrect response. This is uncorrected from previous version.
>
> Two "Press NEXTs" appear in the unit in which the percentage of correct answers on test appears. This is uncorrected from previous version.
>
> An omission of a critical command in certain contexts may lead to an inadvertent return to the beginning of the lesson and loss of about 15-20 minutes work. This is uncorrected from previous version.

"starter"(2)

Because of some faulty coding, part of the section on "Control Circuits" is not functional. Due to the unfinished condition of "starter"(1), this problem could not be detected in the early version.

"transmission"(2)

Some minor non-erasure and overprinting occurs, especially in the feedback position. This is uncorrected from previous version.

"diesel"(2)

Some minor overprinting of lines of text occurs. In one case a slide is available via LAB but its availability is not indicated for the student. This is uncorrected from previous version.

"hydraulics"(2)

The forced review for missing a drill item now works: it was optional in "hydraulics"(1) due to a minor coding problem. In the same drill when the student misses an item three times, the correct answer appears, but it is printed over a subsequent item in the drill. Thus it is difficult to read the correct answer. This is uncorrected from previous version.

"drive shaft"(2)

At various places in the lesson, there is a long wait for the student while special characters are loaded: this impedes the progress of the student. There are a total of six possible loadings of special characters which must occur before the whole lesson is completed. Humerous (?) comments (i.e., "PLATO has now prepared some strokes.") attempt to fill in the delay. This is the same as in previous version.

"PTO"(2)

Due to the unfinished condition of "PTO"(1), all of the following are new problems.

A frame seemingly designed as an introduction (as determined both by its content and its name--"intro") is in fact invisible to all students except those who fail a particular question. Then they are sent back to this unit as part of a forced review.

One question requests the student to name two kinds of transfer cases but the judging sequence will count either half of the answer as completely correct. A very minor change, indicated in the print-out, will prevent this from occurring.

A "PRESS NEXT" appears at the bottom of the page but a student response must be made before the student can move on from this place. In essence, the NEXT key is non-functional at this point, and the directions can confuse the student.

"electricity"(2)

Pressing LAB at one point takes the student back to the beginning of the test. At that point, the directions in large letters, "DO NOT PRESS NEXT", overprint on "Press -NEXT-" in normal size writing. This is a new problem.

Summary on Code

Thus it is evident that some problems, most not of a serious nature, remain in these lessons. These errors may prove to be a nuisance or a source of confusion to students working through the lesson. Of the minor problems, none would require extensive reworking of the code to correct. Indeed some problems, such as the overprinting in "electricity"(2) above, had been corrected as of September 1975, when Varian copies of the block directory pages were made for these lessons.

As part of the overall evaluation of Chanute lessons, the MTC staff has monitored the use of these lessons at Chanute and at Parkland College. We were somewhat surprised to find that execution errors were still occurring after lessons had been used by several hundred students. Under ordinary circumstances, 20-50 students should discover all errors. Although a number of the problems reported by MTC staff have been fixed, some have remained and continue to cause execution errors for other students. Minor problems of overprinting can be excused by insufficient

manpower to "polish" the lessons, but it is more difficult to explain away more serious problems that interrupt progress in the lesson.

New material

A small amount of new material has been added to these lessons. In most cases it consists of "teaching points," reworkings of old questions, and rephrasing of some items of feedback. These have already been discussed in the Overview (sections on General Comments: Components, Specific Comments: Interaction and Feedback.) In some cases, whole units of new information have been added:

"transmission"(2)

A small unit containing new material on the torque converter and fluid coupling has been inserted here.

"PTO"(2)

Due to the unfinished state of "PTO"(1), almost all the material here is new.

Summary and Conclusions

The various categories of specific comments can be summarized as follows:

1) The by-pass option has been eliminated in all but one of these lessons--"transmission"(2).

2) The objectives of these lessons have not changed.

3) The amount of interaction specifically related to the end of lesson tests has increased.

4) With certain notable exceptions, coding problems have ceased to be an important factor in these later lessons.

5) In several cases new material has been removed from the feedback position and put into new separate units.

6) All lessons are fully operational and have their full complement of complete units.

Based on the way that these eight lessons changed from their pre-validation to their validated form, one can characterize the process of revision to improve validation capability as follows:

1) Lessons which validated quickly were not appreciably changed; typically only coding errors were corrected.

2) Long lessons which did not validate quickly were divided into 2-4 pieces. (This information is based in part on conversations with Chanute staff authors and data not found in the eight lessons examined in this report.)

3) In general, the objectives or criteria were not changed.

4) By looking at item results from the end of lesson tests, questions with consistently low performance were identified. In some cases, these items or the whole tests were rewritten; in most cases, information to aid student performance on those items was stressed in the body of the lesson. Emphasis was provided by giving the student questions similar to those on the end of lesson test. When an item was already covered with a question in the body of the lesson, the feedback warned the student to remember the answer for the test.

5) When the student was having difficulty answering the question in the body of the lesson, correct answers and important terms were accented with various special display techniques.

6) Indices were provided to allow the student self reviews, and some lessons were reorganized, possibly to improve the flow of the lesson.

7) Minor problems--such as overprinting of several layers of text, partial erasures, or non-functional instructions to the student--are not fixed unless they significantly interfered with the student's progress.

8) Execution errors still occur after more than one year of student use.

Observations from Chanute

1) Many changes were imposed to attempt standardization of lessons (written prior to June 1974). During ISD development, most effort was expended on new lessons; the prepared lessons were not modified until validation.

2) Many changes were the result of the initial use of poor programming techniques.

3) From the Chanute evaluator's observations of the effort and others, it seems implicit to the instructional programming philosophy that students will learn in spite of the techniques used. Consequently the importance of validation techniques--when considered as a group--lay in the debugging of a lesson, making it usable for the majority of students. Though it seems like heresy to observe cases of

    a. reduced standards,
    b. cuing students to test items,
    c. dividing lessons to facilitate validation,
    d. pretest item practice, and
    e. reduction in item difficulty,

    a perjorative impact on lesson performance outcomes[1] was not noted. Validation techniques are arbitrary in many cases, and therefore can be flexible, for the end result is a viable product.

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[2]The evaluator is not speaking of the end of lesson test--obviously these should improve--rather he refers to the block exams, instructor assessment, field evaluation, etc.

Appendix I: The Eight Chanute Lessons Selected

emission(1)	= mtcc1	emission(2)	= mtcc10
starter(1)	= mtcc2	starter(2)	= mtcc11
transmission(1)	= mtcc3	transmission(2)	= mtcc12
diesel(1)	= mtcc4	diesel(2)	= mtcc13
hydraulics(1)	= mtcc5	hydraulics(2)	= mtcc14
drive shaft(1)	= mtcc6	drive shaft(2)	= mtcc15
power take off = PTO	= mtcc7	PTO(2)	= mtcc16
electricity(1)	= mtcc8	electricity	= mtcc18

Appendix II: Stressing of End of Lesson Test Items via Interaction in "diesel"(2)

The following table gives information on the relationship of interaction to test items in one particular lesson. This lesson was chosen because of the particular way in which test items are stressed in the body of the lesson. Each "X" represents one occurrence of the designated characteristic. The stressing of information can be divided into specific categories:

%	=	percentage of students answering question correctly (79 cases total)
i/a(dir)	=	virtually identical questions in the body of the lesson
i/a(indir)	=	related question/answer stressed by interaction
text	=	information for answer provided in text, but not emphasized
f/b	=	answer to this question provided in the feedback to another question
blatant 1	=	feedback to a question gives "Remember this for test." It appears in "emission"(2) but NOT in "emission"(1).
blatant 2	=	strong warning in text: "Don't forget (this)" and/or answer set off from normal text via unusual positioning or special characters. It also appears in the later version of "emission" only.

Q	%	i/a(dir)	(i/a(indir)	text	f/b	blatant 1	blatant 2
1	100			X			
2	85	X		X		X	
3	99			XX			
4	94		X	X	X		
5	75			X			X
6	71						X
7	90			XX			
8	89			X			
9	85		X	X	X		
10	85			X			

Summary of and conclusions to be drawn from Appendix II:

1) Extra assistance is provided in the form of strong hints to remember certain bits of data.

2) Some of the answers to test items appear at oblique places in the lesson (i.e., within textual passages or in related questions).

3) As mentioned above, some are hinted at so strongly it is as if they were stressed before the student sees them on the final test.

4) Two of the questions (#5 and #6) are given very heavy stress by the use of strong hints: thus their percentage correct figures may have been inflated.

Appendix III: Modifications of Test Items in "emission"(2)

There are two tests: a final quiz (no longer equal to a by-pass test) and an end of lesson test. The former is unchanged; in the end of lesson test, however, there is a slight rephrasing of two questions which makes for clarity and less confusion for the student looking for the right answer. Comparison of the two may help to show what has been done to improve the precision of the questions asked. First the questions from "emission"(1):

2. ____	Component that uses engine vacuum to draw gasses from crankcase intake manifold.	d. PCV
3. ____	Vane-type rotary	a. air pump

In #2, the phrasing is misleading: it is actually the vacuum that operates the pcv valve; the valve does not "use" the vacuum. In the following question, there is a problem: another possible match, "h. air injection," would be just as likely a choice, and as correct, as the one allowed, "a. air pump."

The following are the corrected versions of the questions as well as the change in the phrasing of the correct answers:

2. ____	Valve that is operated by engine vacuum and draws gasses from the crankcase to the intake manifold.	d. PCV valve
3. ____	Type of pump used on air injections system.	a. Vane type rotary pump

The author seems to be aware of the original vagueness in the questions in "emission"(1) and has taken steps to correct the problem. Also the appearance of "valve" and "pump" in both the description and the desired answer is a strong prompt.

Results. The rephrasing of the two questions and the addition of a question, as mentioned in the section on interaction, increases the total of test items previously stressed by interaction to 70% in "emission"(2).

Appendix IV: Teaching Points

The following is a table listing the occurrences or absence of a section called "teaching points" that appears in some of these lessons. If present, the section is only accessible to an author, NOT a student, via DATA at the appropriate place in the lesson. In some cases, directions are given as to its presence. In others it must be discerned from an examination of the printout.

Lesson	Present?	Directions given?
emission(1)	no	---
emission(2)	yes	yes
starter(1)	no	---
starter(2)	yes	no
transmission(1)	no	---
transmission(2)	yes	no
diesel(1)	no	---
diesel(2)	yes	yes
hydraulics(1)	no	---
hydraulics(2)	yes	no
drive shaft(1)	no	---
drive shaft(2)	yes	no
PTO(1)	no	---
PTO(2)	yes	no
electricity(1)	yes	no
electricity(2)	yes	no

Appendix V: Lessons Reviewed for this Report Available in a "fixed" and "unfixed" Form

"Fixed" and "unfixed" Lesson Names

Lesson	Fixed form	Unfixed form
emission	mtcc10	cha3 + some material from cha63
starter	mtcc11	cha41
transmission[a]	mtcc12	cha73
diesel	mtcc13	cha74 + end of lesson test in cha13
hydraulics	mtcc14	cha78 + some material in cha80/84
drive shaft	mtcc15	cha82
power take off[a]	mtcc16	cha86
electricity	mtcc18	cha97 + other lessons listed in index as sections: cha37, 100, and 43

[a]Lessons in which both forms are by the same author.

The answers to the questions which are strongly hinted at (see Appendix II) are found in the "cha" lesson; thus comments as to when they were inserted and how well students performed on them (stored in data records) are difficult to correlate due to the "non-fixed" state of the lesson.

Some additional comments to keep in mind:

1) the sequence of movement of the student is from the first "cha" lesson to the others via a -jumpout-;

2) all the "cha" lessons have been subjected to frequent editing so that they are NOT exact equivalents to their mtcc counterparts.

Appendix VI: A Survey of Major and Minor Changes in these Lessons

Lesson	organz	termnlg	questn	visual	feedbk	test	coding
emission			X	×		×	×
starter	X		X	X		X	×
transmission	X	×	X	×		X	
diesel	×			×			
hydraulics							×
drive shaft			×			X	
PTO	X	X	X	X	×	X	×
electricity				×			×

Explanation: X = changes of major importance (one or more)

× = changes of minor importance

Several changes were not noted because they seemed obviously to be the completion of previously unfinished work rather than modifications based on student usage. For example, the two lessons--"starter"(2) and "PTO"(2) now have objectives; the early versions did not. Not included are two "across the board" changes affecting essentially every lesson: removal of by-pass tests, except for "diesel"(2), and addition of teaching points accessible to instructors.

Conclusions:

1) "PTO" was changed considerably while "hydraulics" was relatively unmodified.

2) "Starter" and "transmission" reflected extensive changes while "diesel" and "drive shaft" did not.